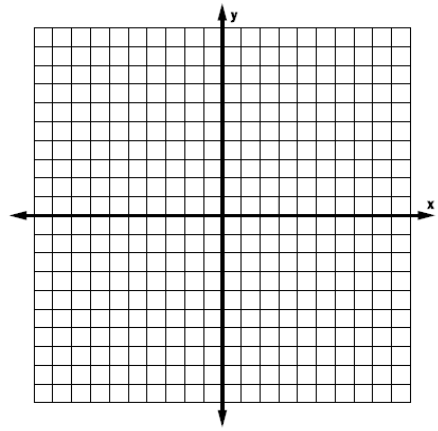
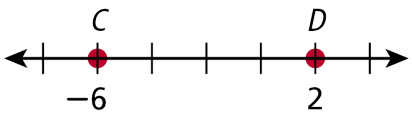
<u>Attendance Problems</u>.

1. Graph *A* (–2, 3) and *B* (1, 0).



2. Find CD.



3.Find the coordinate of the midpoint of $\overline{CD}$.

4. Simplify $\sqrt{\left(3-(-1)\right)^2}$

Vocabulary		
coordinate plane	leg	hypotenuse

- I can develop and apply the formula for midpoint.
- I can use the Distance Formula and the Pythagorean Theorem to find the distance between two points.

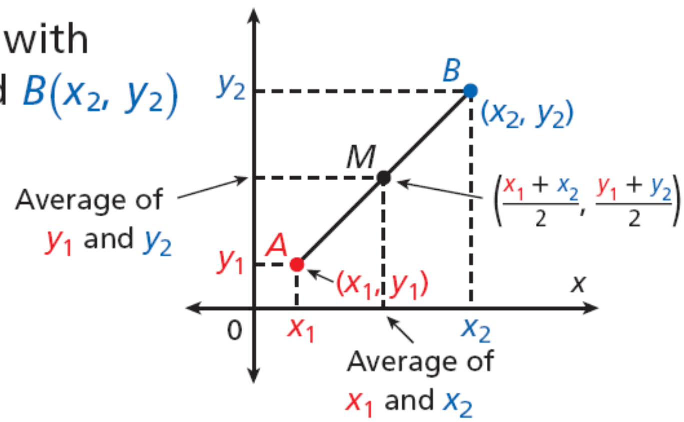
<u>**Common Core**</u>: **CC.9-12.G.GPE.7** Use coordinates to compute perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula.

You can find the midpoint of a segment by using the coordinates of its endpoints. Calculate the average of the *x*-coordinates and the average of the *y*-coordinates of the endpoints.

Midpoint Formula

The midpoint M of $\overline{AB}$ with endpoints $A(x_1, y_1)$ and $B(x_2, y_2)$ is found by

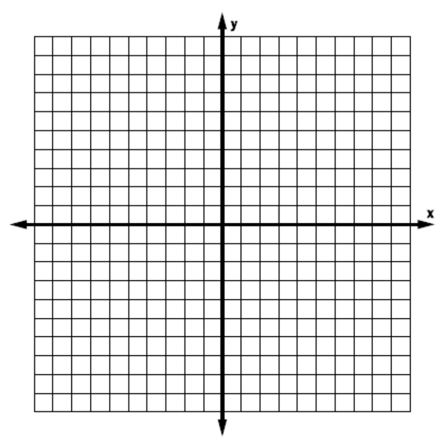
$$M\left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2}\right).$$



Helpful Hint

To make it easier to picture the problem, plot the segment's endpoints on a coordinate plane.

<u>Refer to Video Example 1</u>. Find the coordinates of the midpoint of $\overline{CD}$ with endpoints C(3, 4) and D(1, -2).



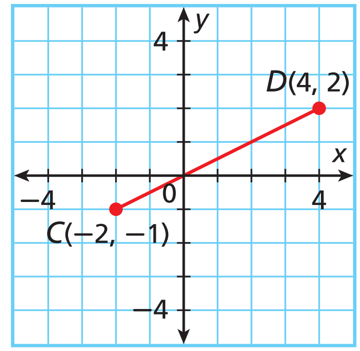
1 Finding the Coordinates of a Midpoint

Find the coordinates of the midpoint of $\overline{CD}$ with endpoints $C(-2, -1)$ and $D(4, 2)$.

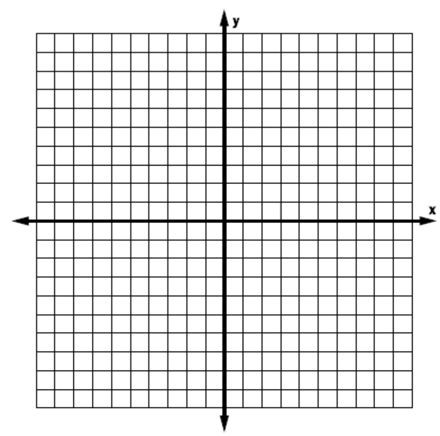
$$M\left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2}\right)$$

$$\frac{-2 + 4}{2}, \frac{-1 + 2}{2} = \left(\frac{2}{2}, \frac{1}{2}\right)$$

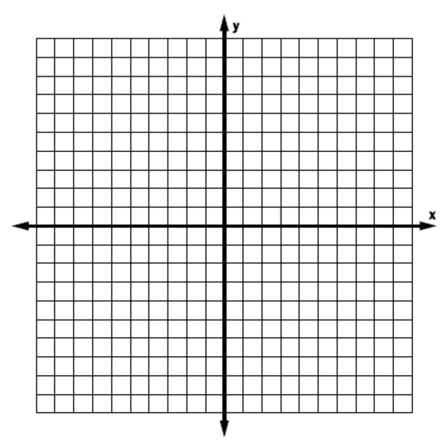
$$= \left(1, \frac{1}{2}\right)$$



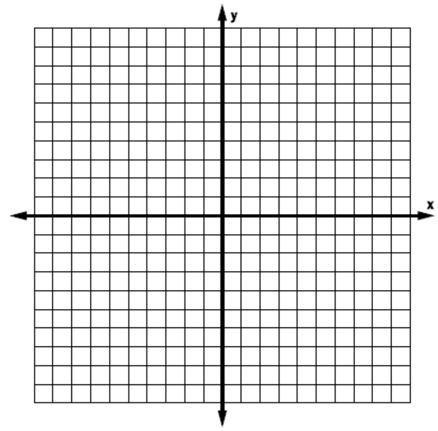
<u>Example 1</u>. Find the coordinates of the midpoint of *PQ* with endpoints *P*(–8, 3) and *Q*(–2, 7).



5. <u>Guided Practice</u>. Find the coordinates of the midpoint of *EF* with endpoints *E*(–2, 3) and *F*(5, –3).



<u>Video Example 2</u>. M is the midpoint of $\overline{AB}$. A has coordinates (3, 5), and M has coordinates (4, -3). Find the coordinates of B.



2 Finding the Coordinates of an Endpoint

***M* is the midpoint of $\overline{AB}$. *A* has coordinates $(2, 2)$, and *M* has coordinates $(4, -3)$. Find the coordinates of *B*.**

Step 1 Let the coordinates of *B* equal (x, y).

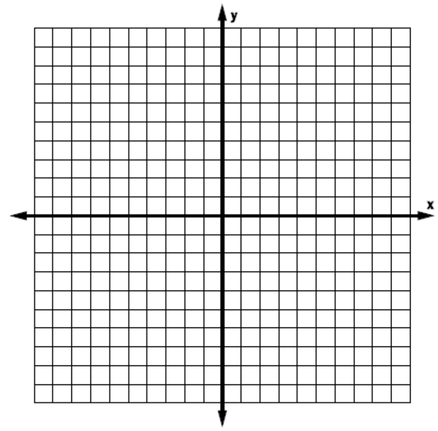
Step 2 Use the Midpoint Formula: $(4, -3) = \left(\frac{2+x}{2}, \frac{2+y}{2}\right)$.

Step 3 Find the *x*-coordinate. Find the *y*-coordinate.

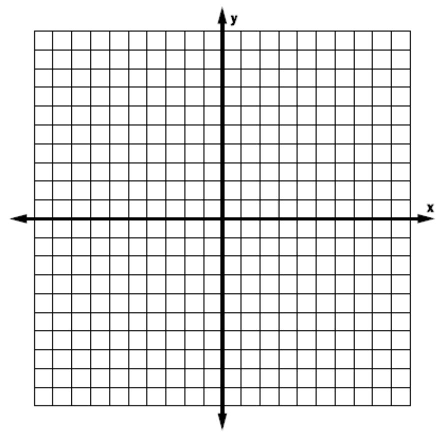
Find the *x*-coordinate.		Find the *y*-coordinate.
$4 = \frac{2+x}{2}$	*Set the coordinates equal.*	$-3 = \frac{2+y}{2}$
$2(4) = 2\left(\frac{2+x}{2}\right)$	*Multiply both sides by 2.*	$2(-3) = 2\left(\frac{2+y}{2}\right)$
$8 = 2 + x$	*Simplify.*	$-6 = 2 + y$
$-2 \quad -2$	*Subtract 2 from both sides.*	$-2 \quad -2$
$6 = x$	*Simplify.*	$-8 = y$

The coordinates of *B* are $(6, -8)$.

<u>Example 2</u>. M is the midpoint of $\overline{XY}$. X has coordinates (2, 7) and M has coordinates (6, 1). Find the coordinates of Y.



6. <u>Guided Practice</u>. *S* is the midpoint of $\overline{RT}$. *R* has coordinates (–6, –1), and *S* has coordinates (–1, 1). Find the coordinates of *T*.

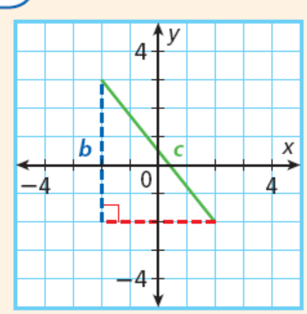


You can use the Pythagorean Theorem to find the distance between two points in a coordinate plane. You will learn more about the Pythagorean Theorem in Chapter 5.

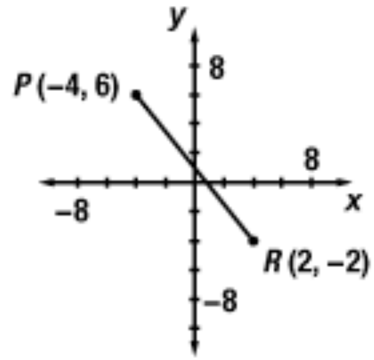
Theorem 1-6-1 Pythagorean Theorem

In a right triangle, the sum of the squares of the lengths of the *legs* is equal to the square of the length of the *hypotenuse*.

$$a^2 + b^2 = c^2$$

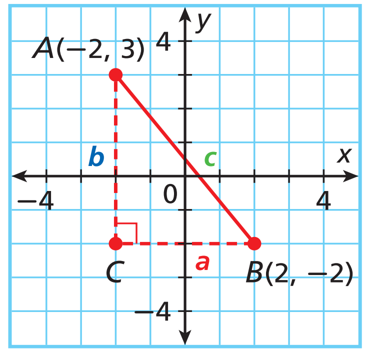


<u>Video Example 4</u>. Use the Pythagorean Theorem to find the distance to the nearest tenth from P to R.



4 Finding Distances in the Coordinate Plane

Use the Distance Formula and the Pythagorean Theorem to find the distance, to the nearest tenth, from *A* to *B*.



Method 1

Use the Distance Formula. Substitute the values for the coordinates of *A* and *B* into the Distance Formula.

$$\begin{aligned} AB &= \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \\ &= \sqrt{[2 - (-2)]^2 + (-2 - 3)^2} \\ &= \sqrt{4^2 + (-5)^2} \\ &= \sqrt{16 + 25} \\ &= \sqrt{41} \\ &\approx 6.4 \end{aligned}$$

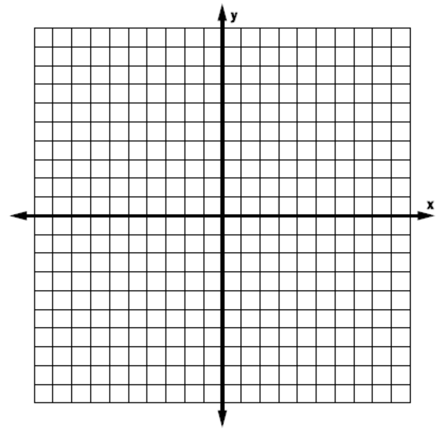
Method 2

Use the Pythagorean Theorem. Count the units for sides *a* and *b*.

$a = 4$ and $b = 5$.

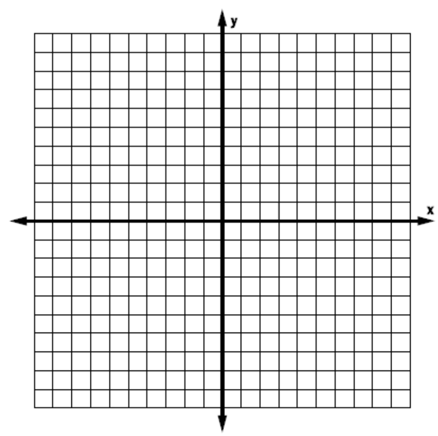
$$\begin{aligned} c^2 &= a^2 + b^2 \\ &= 4^2 + 5^2 \\ &= 16 + 25 \\ &= 41 \\ c &= \sqrt{41} \\ c &\approx 6.4 \end{aligned}$$

Example 4. Use the the Pythagorean Theorem to find the distance, to the nearest tenth, from *D*(3, 4) to *E*(–2, –5).

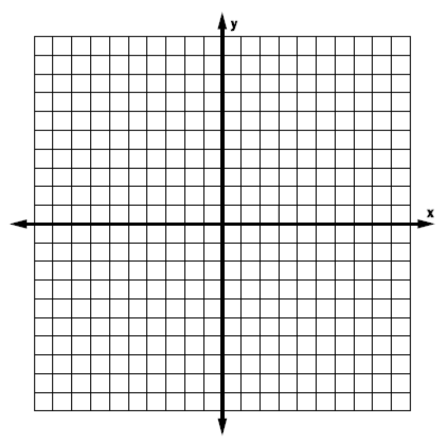


Guided Practice.

7. Use the the Pythagorean Theorem to find the distance, to the nearest tenth, from *R*(3, 2) to *S*(–3, –1).



8. Use the the Pythagorean Theorem to find the distance, to the nearest tenth, from *R*(-4, 5) to *S*(2, –1).



Distance Formula

In a coordinate plane, the distance d between two points (x_1, y_1) and (x_2, y_2) is

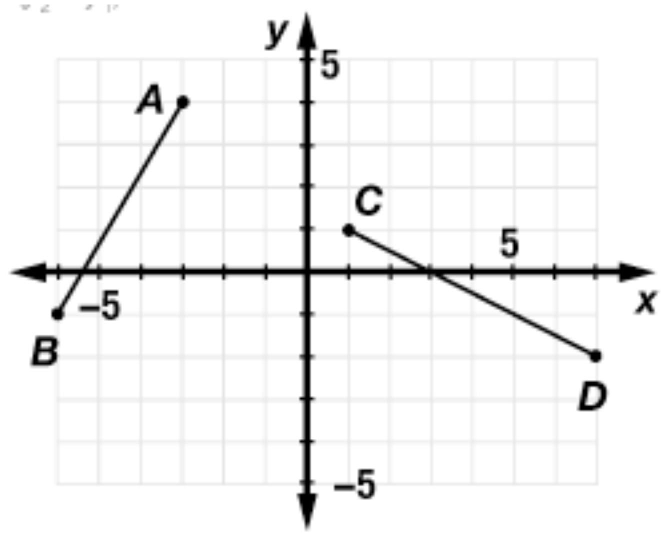
$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}.$$

The Distance Formula

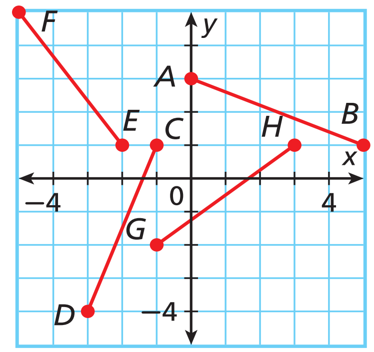
(On Top of Old Smokey)

When finding the distance Between two points,
Subtract the two x's
Do the same for the y's.
Now square both these numbers, And find out their sum.
When you take the square root Then you are all done!

Video Example 3. Find AB and CD. Then determine if AB < CD.



3 Using the Distance Formula



Find AB and CD. Then determine if $\overline{AB} \cong \overline{CD}$.

Step 1 Find the coordinates of each point.

$A(0, 3)$, $B(5, 1)$, $C(-1, 1)$, and $D(-3, -4)$

Step 2 Use the Distance Formula.

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

$$AB = \sqrt{(5 - 0)^2 + (1 - 3)^2} \qquad CD = \sqrt{[-3 - (-1)]^2 + (-4 - 1)^2}$$

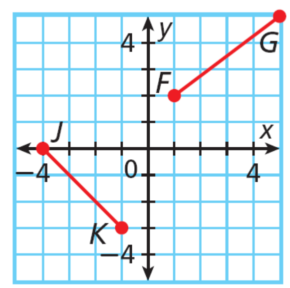
$$= \sqrt{5^2 + (-2)^2} \qquad = \sqrt{(-2)^2 + (-5)^2}$$

$$= \sqrt{25 + 4} \qquad = \sqrt{4 + 25}$$

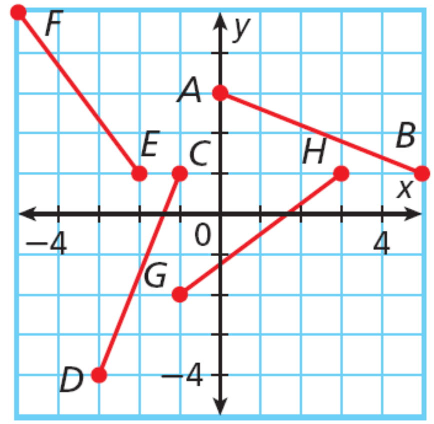
$$= \sqrt{29} \qquad = \sqrt{29}$$

Since $AB = CD$, $\overline{AB} \cong \overline{CD}$.

<u>Example 3</u>. Find FG and JK. Then determine whether $\overline{FG} \cong \overline{JK}$.

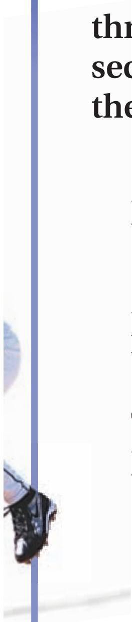


8. <u>Guided Practice.</u> Find *EF* and *GH*. Then determine if $\overline{EF} \cong \overline{GH}$.

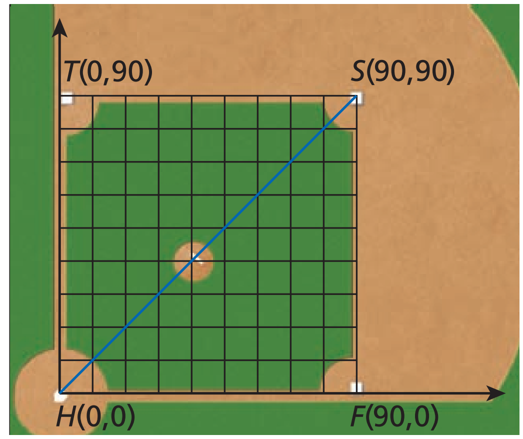


<u>Video Example 5</u>. The four bases on a little league baseball field form a square with 50 ft sides. When a player throws the ball from first base to third base, what is the distance of the throw to the nearest tenth?

5 Sports Application



The four bases on a baseball field form a square with 90 ft sides. When a player throws the ball from home plate to second base, what is the distance of the throw, to the nearest tenth?

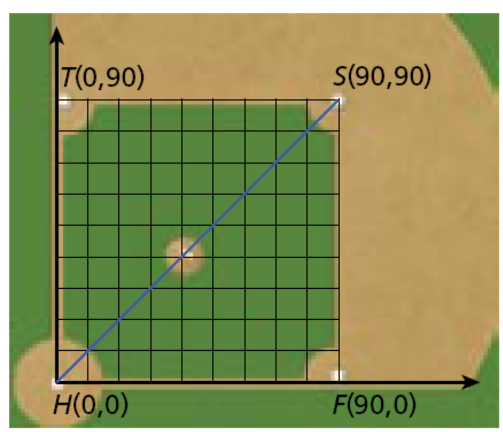


Set up the field on a coordinate plane so that home plate H is at the origin, first base F has coordinates $(90, 0)$, second base S has coordinates $(90, 90)$, and third base T has coordinates $(0, 90)$.

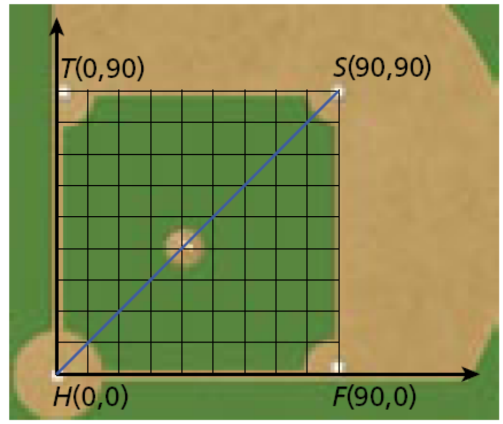
The distance HS from home plate to second base is the length of the hypotenuse of a right triangle.

$$
\begin{aligned}
HS &= \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \\
&= \sqrt{(90 - 0)^2 + (90 - 0)^2} \\
&= \sqrt{90^2 + 90^2} \\
&= \sqrt{8100 + 8100} \\
&= \sqrt{16{,}200} \\
&\approx 127.3 \text{ ft}
\end{aligned}
$$

Example 5. A player throws the ball from first base to a point located between third base and home plate and 10 feet from third base. What is the distance of the throw, to the nearest tenth?



9. <u>Guided Practice</u>. The center of the pitching mound has coordinates (42.8, 42.8). When a pitcher throws the ball from the center of the mound to home plate, what is the distance of the throw, to the nearest tenth?



1-6 Midpoint and Distance in the Coordinate Plane: (p 47) 12-17, 19, 20, 22, 24, 25, 26, 29-33.